I. **PATENT ABSTRACTS OF JAPAN**

(11)Publication number : **2002-246054**

(43)Date of publication of application : **30.08.2002**

(51)Int.Cl. H01M 8/04

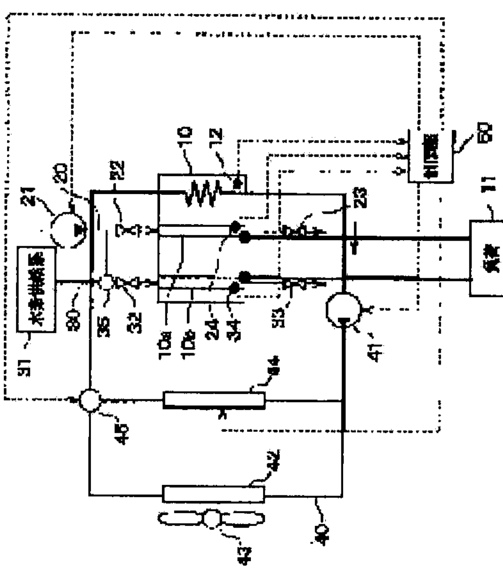
(21)Application number : **2001-035935**

(22)Date of filing : **13.02.2001**

(71)Applicant : **DENSO CORP**

(72)Inventor : **IMAMURA TOMONORI**
**SASAKI HIROKUNI**
**KATO HARUHIKO**
**OKAMOTO KUNIO**
**HOTTA NAOTO**

## (54) FUEL CELL SYSTEM



(57)Abstract:

PROBLEM TO BE SOLVED: To provide a fuel cell system which is used under a low-temperature environment, capable of removing water inside a fuel cell in a short time, when operation is stopped.

SOLUTION: A cooling water path 40 for circulating cooling water in the fuel cell 10 is provided with cooling parts 42, 43 for cooling cooling water, when normal operation of the fuel cell 10 is performed and a heating part 44 for heating cooling water, when water removing operation is performed; and a flow passage of cooling water is constituted so as to switch to cooling part 42, 43 sides or a heating part 44 side. After normal operation of the fuel cell 10 is ended, prescribed dry air is supplied into an air path 20 and a hydrogen path 30, and the flow passage of cooling water is switched to the heating part 44 side so as to heat the fuel cell 10 up to a prescribed temperature.

2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

## CLAIMS

[Claim(s)]
[Claim 1]A fuel cell system characterized by heating said fuel cell (10) to prescribed temperature by said heating method (44) while having the following and supplying a predetermined dry gas to said air path (20) and said hydrogen path (30) after usual shutdown of said fuel cell (10).
An air path (20) which is a fuel cell system provided with a fuel cell (10) which carries out electrochemical reaction of hydrogen and the oxygen, and obtains electric power, and oxygen supplied to said fuel cell (10) passes.
A hydrogen path (30) which hydrogen supplied to said fuel cell (10) passes.
A heating method (44) which heats said fuel cell (10).

[Claim 2]The fuel cell system according to claim 1, wherein said dry gas is air.
[Claim 3]said heating method is [ in / have the following and / said cooling water route (40) ] in parallel with said cooling unit (42, 43) -- it being provided-like or in in-series, and, Are a heating unit (44) which heats said cooling water, and a channel of said cooling water is constituted switchable at said said cooling unit (42, 43) or heating unit (44) side, The fuel cell system according to claim 1 or 2 characterized by changing a channel of said cooling water to said heating unit (44) side after an end of usual operation of said fuel cell (10) when heating said fuel cell (10).
A cooling-water-flow course (40) which makes said fuel cell (10) circulate through cooling water.
A cooling unit which is provided in said cooling water route (40), and cools said cooling water at the time of usual operation of said fuel cell (10) (42, 43).

[Claim 4]It has a temperature sensor (12) which detects temperature of said fuel cell (10), A fuel cell system of any one statement of claim 1 thru/or 3 controlling cooking temperature of said fuel cell (10) by said heating method (44) based on temperature detected with said temperature sensor (12).

## DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]In this invention, it is related with the fuel cell system which consists of a fuel cell which generates electrical energy by the chemical reaction of hydrogen and oxygen. Therefore, it applies to mobiles, such as vehicles, a marine vessel, and a portable electric organ, and is effective.

[0002]
[Description of the Prior Art]The fuel cell system conventionally provided with the fuel cell which generates electricity using the electrochemical reaction of hydrogen and oxygen (air) is

known. For example, with the polyelectrolyte type fuel cell considered as driving sources for vehicles etc., by a cold condition 0 ** or less, the moisture which exists in electrode vicinity freezes and there is a problem that check diffusion of reactant gas or the conductivity of an electrolyte membrane falls.

[0003]When starting a fuel cell under such low temperature environment, by blinding of the reactant gas course by freezing, or inhibition of advance and attainment of the reactant gas (hydrogen and air) to an electrolyte membrane, even if it supplies fuel gas, electrochemical reaction does not advance, but there is a problem that a fuel cell cannot be started. The blockade of the gas path by freezing of the moisture which dewed within the reactant gas course is also produced.

[0004]In order to prevent freezing inside a fuel cell and to raise low-temperature starting nature, to remove beforehand the moisture frozen under low temperature environment from the inside of a fuel cell is desired. For this reason, it is possible by supplying air in a fuel cell to remove the moisture in a fuel cell by airstream.

[0005]

[Problem(s) to be Solved by the Invention]However, when airstream removes the moisture in a fuel cell, heat will be taken by the latent heat of vaporization in the case of moisture evaporation, and the temperature inside a fuel cell will fall. There is a problem that the amount of evaporation of moisture falls and the water removal in a fuel cell takes time by this.

[0006]In view of the above-mentioned problem, an object of this invention is to provide the fuel cell system the moisture inside a fuel cell can be [ a fuel cell system ] removable in a short time in the fuel cell system used under low temperature environment in the case of shutdown.

[0007]

[Means for Solving the Problem]In order to attain the above-mentioned purpose, in the invention according to claim 1. An air path (20) which oxygen which is a fuel cell system provided with a fuel cell (10) which carries out electrochemical reaction of hydrogen and the oxygen, and obtains electric power, and is supplied to a fuel cell (10) passes, A hydrogen path (30) which hydrogen supplied to a fuel cell (10) passes, While having a heating method (44) which heats a fuel cell (10) and supplying a predetermined dry gas to an air path (20) and a hydrogen path (30) after usual shutdown of a fuel cell (10), it is characterized by heating a fuel cell (10) to prescribed temperature by a heating method (44).

[0008]Thus, by heating a fuel cell (10) simultaneously with gas supply, fuel cell temperature can be prevented from falling in connection with moisture evaporation at the time of water removal operation. By this, evaporation of residual water inside a fuel cell (10) can be promoted, water removal inside a fuel cell (10) can be performed in a short time, freezing of a fuel cell can be avoided, and the starting nature of a fuel cell (10) under low temperature can be raised.

[0009]In the invention according to claim 2, a dry gas is characterized by being air. Thus, water removal can be performed by using air, without forming a special gas supply device. Dry air can be provided by not performing humidification to air usually performed at the time of operation.

[0010]A cooling-water-flow course (40) which makes a fuel cell (10) circulate through cooling water in the invention according to claim 3, It is provided in a cooling water route (40), have a cooling unit (42, 43) which cools cooling water at the time of usual operation of a fuel cell (10), and a heating method, in parallel with a cooling unit (42, 43) in a cooling water route (40) -- it being provided-like or in in-series, and, Are a heating unit (44) which heats cooling water, and a channel of cooling water is constituted switchable at the cooling unit (42, 43) or heating unit (44) side, After an end of usual operation of a fuel cell (10), when heating a fuel cell (10), it is

characterized by changing a channel of cooling water to the heating unit (44) side.
[0011]By such composition, the existing fuel cell cooling system can be used and a fuel cell (10) can be heated with simple composition which adds a heating unit (44) of cooling water to this.
[0012]In the invention according to claim 4, it has a temperature sensor (12) which detects temperature of a fuel cell (10), and is characterized by controlling cooking temperature of a fuel cell (10) by a heating method (44) based on temperature detected with a temperature sensor (12). It can maintain at temperature which can evaporate residual water efficiently by this in the range which does not destroy fuel cell temperature for an electrolyte membrane of a fuel cell (10), etc.
[0013]Numerals in a parenthesis of each above-mentioned means show a correspondence relation with a concrete means of a statement to an embodiment mentioned later.
[0014]
[Embodiment of the Invention]Hereafter, the embodiment of this invention is described based on drawing 1 and drawing 2. This embodiment applies a fuel cell system to the electromobile (fuel cell vehicle) which runs a fuel cell as a power supply.
[0015]Drawing 1 shows the entire configuration of the fuel cell system of this embodiment. As shown in drawing 1, the fuel cell system of this embodiment is provided with the fuel cell (FC stack) 10 which generates electric power using the electrochemical reaction of hydrogen and oxygen. FC stack 10 is constituted so that electric power may be supplied to electric appliances, such as the electric motor 11 for vehicle running (load), and a rechargeable battery which is not illustrated.
[0016]In FC stack 10, the electrochemical reaction of the following hydrogen and oxygen occurs and electrical energy occurs.
(Negative-electrode side) The solid polyelectrolyte type fuel cell is used as FC stack 10, the plural laminates of the cell used as a basic unit are carried out, and it comprises an $H_2$->$2H^+$+$2e^-$ (anode side) $2H^+$+$1/2O_2$+$2e^-$->$H_2O$ this embodiment. Each cell has the composition that the electrolyte membrane was pinched by the electrode of the couple. The temperature sensor 12 for detecting the temperature of an FC stack main part is formed in FC stack 10.
[0017]The air path 20 for supplying air (oxygen) to the oxygen pole (anode) 10a side of FC stack 10 and the hydrogen path 30 for supplying hydrogen to the hydrogen pole (negative electrode) 10b side of FC stack 10 are formed in the fuel cell system. The fan 21 for the air sending for air supply (gas-compression machine) is formed in the air path 20. Hydrogen is supplied to the hydrogen path 30 from the hydrogen supply system 31.
[0018]It is necessary to make the electrolyte membrane in FC stack 10 into the damp or wet condition having contained moisture for the electrochemical reaction at the time of power generation. For this reason, at the time of operation, humidification is performed in the air of the air path 20, and hydrogen of the hydrogen path 30 by the humidifying device which is not illustrated, and the air and hydrogen which were humidified are usually supplied to FC stack 10. By this, FC stack 10 inside will operate by a damp or wet condition. In the oxygen pole 10a side, moisture generates according to the above-mentioned electrochemical reaction.
[0019]At the time of the below-mentioned water removal operation, the dry air which is not humidified and the dry hydrogen which is not humidified are supplied to FC stack 10. In order to remove the moisture which remains in FC stack 10, as for these dry gases, it needs to be desirable that it is low humidity as much as possible, and they need to be low humidity from the humidity in FC stack 10 at least.
[0020]The shut valves 22 and 23 for intercepting the air path 20 are formed in the both ends in the air path 20. FC stack 10 and air path 20 inside can be intercepted from the open air by closing

these shut valves 22 and 23. The same shut valves 32 and 33 are formed also in the both ends of the hydrogen path 30.

[0021]The air path 20 and the hydrogen path 30 are connected in the upstream of FC stack 10. The hydrogen path selector valve 35 is prepared for the terminal area in the hydrogen path 30. By changing the hydrogen path selector valve 35, at the time of operation, hydrogen from the hydrogen supply system 31 can usually be passed to the hydrogen path 30, and the air from the air path 20 can be passed to the hydrogen path 30 at the time of water removal operation.

[0022]The water content sensors 24 and 34 for detecting the residual water which exists in the oxygen pole 10a and the hydrogen pole 10b of FC stack 10 inside are formed in FC stack 10. According to this embodiment, the humidity sensor is used as the water content sensors 24 and 34. As for the humidity sensors 24 and 34, in order to detect the humidity of FC stack 10 inside appropriately, it is desirable to provide near [ in the oxygen pole 10a and the hydrogen pole 10b ] FC stack 10 exit.

[0023]FC stack 10 produces generation of heat with power generation. For this reason, the cooling systems 40-45 are formed in the fuel cell system so that FC stack 10 may be cooled and operating temperature may become electrochemical reaction with optimal temperature (about 80 **).

[0024]The cooling water route 40 which makes FC stack 10 circulate through cooling water (heat carrier), the water pump 41 made to circulate through cooling water, and the radiator 42 provided with the fan 43 are formed in the cooling system. The cooling unit consists of the radiator 42 and the fan 43.

[0025]The heat generated in FC stack 10 is discharged out of a system with the radiator 42 via cooling water. Such a cooling system can perform cooling amount control of FC stack 10 by the air-flow rate control by the control of flow by the water pump 41, the radiator 42, and the fan 43.

[0026]The heating unit (heating method) 44 for heating cooling water is formed in the cooling system of this embodiment in parallel with the radiator 43. As the heating unit 43, an electric-type heater, a combustion heater, a catalyst heater, etc. can be used, for example. Heating quantity control of cooling water according to the heating unit 44 by such composition and the control of flow by the water pump 41 can perform heating quantity control of FC stack 10.

[0027]The channel of cooling water is changed to the radiator 43 and heating unit 44 side by the cooling water selector valve 45. At the time of usual operation of FC stack 10, the cooling water selector valve 45 is changed to the radiator 43 side, and FC stack 10 is cooled. On the other hand, at the time of water removal operation of FC stack 10 in this embodiment, the cooling water selector valve 45 is changed to the heating unit 44 side, and FC stack 10 is heated.

[0028]The control section (ECU) 50 which performs various control is formed in the fuel cell system of this embodiment. The required power signal from the load 11, the temperature signal from the temperature sensor 12, the amount signal of residual water from the water content sensors 24 and 34, etc. are inputted into the control section 50. The control section 50 is constituted so that a control signal may be outputted to a rechargeable battery, the fan 21, the water pump 41, the radiator fan 43, the heating unit 44, and cooling water selector-valve 45 grade.

[0029]Next, the water removal control in the fuel cell system of the above-mentioned composition is explained based on drawing 2. Drawing 2 is a flow chart which shows water removal control of a fuel cell system.

[0030]First, it is judged whether the water removal (moisture purge) in FC stack 10 is usually required after shutdown (Step S10). The judgment of whether to perform water removal is

performed in consideration of environmental temperature (outside air temperature), season information, etc. at the time of shutdown. That is, based on the said conditions with which environmental temperature is 0 ** or less, or are winter etc., and the falls of atmospheric temperature are predicted to be, the judgment about the necessity for water removal operation is performed. Since there is no fear of freezing with a natural thing on conditions, such as summer, moisture operation is not needed.
[0031]At the time of the shutdown of FC stack 10, it may constitute so that the expected time of FC stack 10 stop time by a driver may be inputted. This is because FC stack 10 does not become [ in preheating of FC stack 10 / below a freezing point ] in an instant enough for a certain reason but an elevated temperature is maintained for the time being, even if environmental temperature is below a freezing point at the time of the stop of FC stack 10. Therefore, if it is in the stop time of about (one whole day and night) 10 hours, it is not necessary to perform residual water removal at the time of shutdown.
[0032]When judged with water removal operation being required at the above-mentioned step S10, the cooling water selector valve 45 is changed to the heating unit 44 side (Step S11). By this, cooling water will be heated by the heating unit 44. Since FC stack 10 has already suspended power generation, the cooling water selector-valve 45 grade operates by the electric power supply from a rechargeable battery.
[0033]Next, the hydrogen path selector valve 35 is changed to the air path 20 side (Step S12), and air blasting control by the fan 21 is performed (Step S13). Thereby, air is supplied to the air path 20 and the hydrogen path 30. At this time, humidification is not performed to air, but dry air is supplied to the oxygen pole 10a and the hydrogen pole 10b of FC stack 10. Thereby, the moisture which exists as a drop in FC stack 10 is blown away by airstream besides FC stack 10.
[0034]Next, the water content sensors 24 and 34 detect the amount of residual water in FC stack 10 (Step S14), and it is judged whether the amount of residual water is less than the freezing range less than the specified quantity (Step S15).
[0035]When the amount of residual water in FC stack 10 is less than the freezing range, the shut valves 22, 23, 32, and 33 provided in the both ends of the air path 20 and the hydrogen path 30 are closed (Step S16). Thereby, FC stack 10, air path 20, and hydrogen path 30 inside is intercepted from the open air, and the water penetration from outside environment can be prevented.
[0036]As a result, when the amount of residual water in FC stack 10 is over the freezing range, FC stack temperature control of the following steps S17-S21 is performed, FC stack 10 is heated, and evaporative removal of the residual water is carried out.
[0037]First, the temperature sensor 12 detects the temperature T of FC stack 10 main part (Step S17), and it is judged whether the FC stack temperature T has exceeded the target temperature Tr (Step S18). The higher possible one of the target temperature Tr is preferred in order to evaporate the moisture in FC stack 10. However, if the target temperature Tr is set not much as an elevated temperature, while causing the constitution increase of the heating unit 44, the electrolyte membrane of FC stack 10 inside is destroyed. Therefore, in order to prevent such faults, the target temperature Tr is set as 80-100 **.
[0038]When the FC stack temperature T has exceeded the target temperature Tr, When the cooling water heating quantity by the heating unit 44 is set as zero (Step S19) and the FC stack temperature T is less than target temperature, the cooling water heating quantity by the heating unit 44 is set as K (Tr-T) [K:proportionality constant] (Step S20). Next, the circulating load of cooling water is controlled by the water pump 41 (Step S21). Thereby, temperature control is

carried out so that the FC stack temperature T may turn into the target temperature Tr. It returns to the above-mentioned step S14 after the above temperature control.
[0039]FC stack 10 inside can be maintained at an elevated temperature, without carrying out a temperature fall in connection with moisture evaporation by performing FC stack temperature control of the above steps S17-S21. Thereby, evaporation of residual water is promoted in FC stack 10 inside. The residual water which evaporated is discharged by the exterior of FC stack 10 in the state where it was contained in the air supplied from the air path 20 and the hydrogen path 30. Since dry air is supplied from the air path 20 and the hydrogen path 30 at this time, the inside of FC stack 10 can be dried efficiently.
[0040](Other embodiments) Although the humidity sensor was used in addition by the above-mentioned embodiment as the water content sensors 24 and 34 which detect the amount of residual water in FC stack 10, The amount of residual water of FC stack 10 inside is detectable not only this but by measuring change of the electrical resistance of the electrolyte membrane in FC stack 10 inside, for example as a water content sensor.
[0041]In each cell which constitutes FC stack 10, water removal at least of the part should just be carried out. If a part of cell is dry, power generation can be started by supplying hydrogen and air to the dry portion. If power generation is started in a part of cell, temperature up of other portions can be carried out by generation of heat accompanying power generation, and it can generate electricity in the whole cell.
[0042]Although dry air was supplied from the air path 20 and the hydrogen path 30 at the time of water removal operation, it may constitute from an above-mentioned embodiment so that not only this but arbitrary gas called nitrogen for example may be supplied.
[0043]When the FC stack temperature T detected at the above-mentioned step S16 is beyond the temperature (for example, 150 **) which destroys an electrolyte membrane, the cooling water selector valve 45 may be changed to the radiator side, and it may constitute so that cooling water may be cooled positively and FC stack 10 may be cooled.
[0044]Although the heating unit 44 which heats cooling water was formed in parallel with the radiator 43 in the above-mentioned embodiment, not only in this but in the cooling water route 40, the heating unit 44 may be formed in in-series with the radiator 43. In this case, it is the upstream of the turning point by the side of the heating unit 44 and a radiator, and what is necessary is just to move the heating unit 44 to the downstream of the water pump 41 in the composition of the fuel cell system of drawing 1. In such composition, the course in which the heating unit 44 was formed turns into a bypass route for making the radiator 42 bypass in cooling water. The cooling water heated by passing the heating unit 44 by such composition when usually performing water removal control after the end of operation passes through a bypass channel, and bypasses the radiator 42.

## TECHNICAL FIELD

[Field of the Invention]In this invention, it is related with the fuel cell system which consists of a fuel cell which generates electrical energy by the chemical reaction of hydrogen and oxygen. Therefore, it applies to mobiles, such as vehicles, a marine vessel, and a portable electric organ, and is effective.

## PRIOR ART

[Description of the Prior Art]The fuel cell system conventionally provided with the fuel cell which generates electricity using the electrochemical reaction of hydrogen and oxygen (air) is known. For example, with the polyelectrolyte type fuel cell considered as driving sources for vehicles etc., by a cold condition 0 ** or less, the moisture which exists in electrode vicinity freezes and there is a problem that check diffusion of reactant gas or the conductivity of an electrolyte membrane falls.
[0003]When starting a fuel cell under such low temperature environment, by blinding of the reactant gas course by freezing, or inhibition of advance and attainment of the reactant gas (hydrogen and air) to an electrolyte membrane, even if it supplies fuel gas, electrochemical reaction does not advance, but there is a problem that a fuel cell cannot be started. The blockade of the gas path by freezing of the moisture which dewed within the reactant gas course is also produced.
[0004]In order to prevent freezing inside a fuel cell and to raise low-temperature starting nature, to remove beforehand the moisture frozen under low temperature environment from the inside of a fuel cell is desired. For this reason, it is possible by supplying air in a fuel cell to remove the moisture in a fuel cell by airstream.

## TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention]However, when airstream removes the moisture in a fuel cell, heat will be taken by the latent heat of vaporization in the case of moisture evaporation, and the temperature inside a fuel cell will fall. There is a problem that the amount of evaporation of moisture falls and the water removal in a fuel cell takes time by this.
[0006]In view of the above-mentioned problem, an object of this invention is to provide the fuel cell system the moisture inside a fuel cell can be [ a fuel cell system ] removable in a short time in the fuel cell system used under low temperature environment in the case of shutdown.

## MEANS

[Means for Solving the Problem]In order to attain the above-mentioned purpose, in the invention according to claim 1. An air path (20) which oxygen which is a fuel cell system provided with a fuel cell (10) which carries out electrochemical reaction of hydrogen and the oxygen, and obtains electric power, and is supplied to a fuel cell (10) passes, A hydrogen path (30) which hydrogen supplied to a fuel cell (10) passes, While having a heating method (44) which heats a fuel cell (10) and supplying a predetermined dry gas to an air path (20) and a hydrogen path (30) after usual shutdown of a fuel cell (10), it is characterized by heating a fuel cell (10) to prescribed temperature by a heating method (44).
[0008]Thus, by heating a fuel cell (10) simultaneously with gas supply, fuel cell temperature can be prevented from falling in connection with moisture evaporation at the time of water removal operation. By this, evaporation of residual water inside a fuel cell (10) can be promoted, water removal inside a fuel cell (10) can be performed in a short time, freezing of a fuel cell can be

avoided, and the starting nature of a fuel cell (10) under low temperature can be raised.
[0009]In the invention according to claim 2, a dry gas is characterized by being air. Thus, water removal can be performed by using air, without forming a special gas supply device. Dry air can be provided by not performing humidification to air usually performed at the time of operation.
[0010]A cooling-water-flow course (40) which makes a fuel cell (10) circulate through cooling water in the invention according to claim 3, It is provided in a cooling water route (40), have a cooling unit (42, 43) which cools cooling water at the time of usual operation of a fuel cell (10), and a heating method, in parallel with a cooling unit (42, 43) in a cooling water route (40) -- it being provided-like or in in-series, and, Are a heating unit (44) which heats cooling water, and a channel of cooling water is constituted switchable at the cooling unit (42, 43) or heating unit (44) side, After an end of usual operation of a fuel cell (10), when heating a fuel cell (10), it is characterized by changing a channel of cooling water to the heating unit (44) side.
[0011]By such composition, the existing fuel cell cooling system can be used and a fuel cell (10) can be heated with simple composition which adds a heating unit (44) of cooling water to this.
[0012]In the invention according to claim 4, it has a temperature sensor (12) which detects temperature of a fuel cell (10), and is characterized by controlling cooking temperature of a fuel cell (10) by a heating method (44) based on temperature detected with a temperature sensor (12). It can maintain at temperature which can evaporate residual water efficiently by this in the range which does not destroy fuel cell temperature for an electrolyte membrane of a fuel cell (10), etc.
[0013]Numerals in a parenthesis of each above-mentioned means show a correspondence relation with a concrete means of a statement to an embodiment mentioned later.
[0014]
[Embodiment of the Invention]Hereafter, the embodiment of this invention is described based on drawing 1 and drawing 2. This embodiment applies a fuel cell system to the electromobile (fuel cell vehicle) which runs a fuel cell as a power supply.
[0015]Drawing 1 shows the entire configuration of the fuel cell system of this embodiment. As shown in drawing 1, the fuel cell system of this embodiment is provided with the fuel cell (FC stack) 10 which generates electric power using the electrochemical reaction of hydrogen and oxygen. FC stack 10 is constituted so that electric power may be supplied to electric appliances, such as the electric motor 11 for vehicle running (load), and a rechargeable battery which is not illustrated.
[0016]In FC stack 10, the electrochemical reaction of the following hydrogen and oxygen occurs and electrical energy occurs.
(Negative-electrode side) The solid polyelectrolyte type fuel cell is used as FC stack 10, the plural laminates of the cell used as a basic unit are carried out, and it comprises an $H_2$->$2H^+$+$2e^-$ (anode side) $2H^+$+$1/2O_2$+$2e^-$->$H_2O$ this embodiment. Each cell has the composition that the electrolyte membrane was pinched by the electrode of the couple. The temperature sensor 12 for detecting the temperature of an FC stack main part is formed in FC stack 10.
[0017]The air path 20 for supplying air (oxygen) to the oxygen pole (anode) 10a side of FC stack 10 and the hydrogen path 30 for supplying hydrogen to the hydrogen pole (negative electrode) 10b side of FC stack 10 are formed in the fuel cell system. The fan 21 for the air sending for air supply (gas-compression machine) is formed in the air path 20. Hydrogen is supplied to the hydrogen path 30 from the hydrogen supply system 31.
[0018]It is necessary to make the electrolyte membrane in FC stack 10 into the damp or wet condition having contained moisture for the electrochemical reaction at the time of power generation. For this reason, at the time of operation, humidification is performed in the air of the

air path 20, and hydrogen of the hydrogen path 30 by the humidifying device which is not illustrated, and the air and hydrogen which were humidified are usually supplied to FC stack 10. By this, FC stack 10 inside will operate by a damp or wet condition. In the oxygen pole 10a side, moisture generates according to the above-mentioned electrochemical reaction.

[0019]At the time of the below-mentioned water removal operation, the dry air which is not humidified and the dry hydrogen which is not humidified are supplied to FC stack 10. In order to remove the moisture which remains in FC stack 10, as for these dry gases, it needs to be desirable that it is low humidity as much as possible, and they need to be low humidity from the humidity in FC stack 10 at least.

[0020]The shut valves 22 and 23 for intercepting the air path 20 are formed in the both ends in the air path 20. FC stack 10 and air path 20 inside can be intercepted from the open air by closing these shut valves 22 and 23. The same shut valves 32 and 33 are formed also in the both ends of the hydrogen path 30.

[0021]The air path 20 and the hydrogen path 30 are connected in the upstream of FC stack 10. The hydrogen path selector valve 35 is prepared for the terminal area in the hydrogen path 30. By changing the hydrogen path selector valve 35, at the time of operation, hydrogen from the hydrogen supply system 31 can usually be passed to the hydrogen path 30, and the air from the air path 20 can be passed to the hydrogen path 30 at the time of water removal operation.

[0022]The water content sensors 24 and 34 for detecting the residual water which exists in the oxygen pole 10a and the hydrogen pole 10b of FC stack 10 inside are formed in FC stack 10. According to this embodiment, the humidity sensor is used as the water content sensors 24 and 34. As for the humidity sensors 24 and 34, in order to detect the humidity of FC stack 10 inside appropriately, it is desirable to provide near [ in the oxygen pole 10a and the hydrogen pole 10b ] FC stack 10 exit.

[0023]FC stack 10 produces generation of heat with power generation. For this reason, the cooling systems 40-45 are formed in the fuel cell system so that FC stack 10 may be cooled and operating temperature may become electrochemical reaction with optimal temperature (about 80 **).

[0024]The cooling water route 40 which makes FC stack 10 circulate through cooling water (heat carrier), the water pump 41 made to circulate through cooling water, and the radiator 42 provided with the fan 43 are formed in the cooling system. The cooling unit consists of the radiator 42 and the fan 43.

[0025]The heat generated in FC stack 10 is discharged out of a system with the radiator 42 via cooling water. Such a cooling system can perform cooling amount control of FC stack 10 by the air-flow rate control by the control of flow by the water pump 41, the radiator 42, and the fan 43.

[0026]The heating unit for heating cooling water to the cooling system of this embodiment

## DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

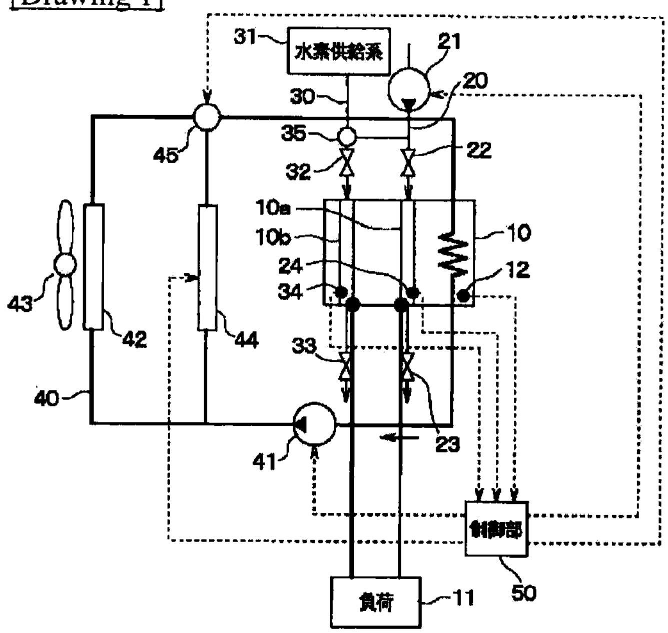
[Drawing 1]It is a key map showing the outline composition of the fuel cell system of the above-mentioned embodiment.

[Drawing 2]It is a flow chart which shows water removal control of the fuel cell system of drawing 1.

[Description of Notations]
10 -- A fuel cell (FC stack), 10a -- An oxygen pole, 10b -- Hydrogen pole, 12 [ -- A hydrogen path, 32, 33 / -- A shut valve, 35 / -- A hydrogen path selector valve, 42 43 / -- A cooling unit, 44 / -- A heating unit (heating method) 50 / -- Control section (ECU). ] -- A temperature sensor, 20 -- An air path, 22, 23 -- A shut valve, 30

## DRAWINGS

[Drawing 1]




[Drawing 2]